CLAIMS

1. A poly-phase electromagnetic device having n winding phases (where n is greater than 2), said device including:

n separate electrical conductor phase windings, each completed phase winding being in the form of a continuous electrical conductor strand;

a magnetically conducive base having a plurality of slots adapted to receive active portions of the phase windings therein;

each phase winding comprising a series of interconnected lap form sub-windings, with each sub-winding defining two active arms that extend through two spaced apart non-adjacent slots in the base, the active arms being joined by one or more suitably formed end turn and/or two connecting arms for connection with adjacent sub-windings or terminals; said active arms and end turn or end turns each formed to include one or more co-extending electrical conductor strands; and

wherein said phase windings are configured such that on assembly of the phase windings to the magnetically conducive base there is a maximum of n-1 sub-winding end turns overlapping, while the lengths of the end turns are simultaneously minimised.

2. A device according to claim 1 wherein said end turn or end turns are each offset from the plane in which the active arms are formed to provide clearance between overlapping end turns and so optimise packing density of electrical conductor within the slots of the magnetically conducive base.

3. An electromagnetic device according to claim 2 having three phases.

4. A device according to claim 3 wherein said lap form sub-winding includes two or more full loops of conductor strand defining two active arms interconnected by two

end turns, each arm and end turn including therein two or more generally co-extending conductor strands, with a lead in and a lead out from said loops defining the respective connecting arms.

5. A device according to claim 4 that has three phase windings each made from lap form sub-windings with alternative sub-windings being wound in opposite directions.

6. A device according to claim 4 wherein said alternate sub-windings have end turns offset in opposite directions.

7. A device according to claim 4 wherein the connecting arms are configured to extend within gaps formed closely adjacent the magnetically conducive base to assist in minimising the overall dimensions of the assembly.

8. A device according to any one of claims 4 to 7 wherein the lap form sub-windings are manufactured in the form of discrete bobbins comprising a multiple number of loops of conductor strand with connecting arms at each end for joining with an adjacent bobbin of the same phase.

9. A device according to any one of claims 4 to 7 wherein the lap form sub-windings are formed from a continuous length of conductor strand to form inter-connected lap form sub-windings.

10. A device according to claim 6 wherein said completed n phase windings are intertwined together in a plait like configuration to achieve n-1 end turn overlaps on assembly into the magnetically conducive base.

11. A device according to claim 5 wherein said connecting arms are located at different corners for a reverse wound lap form sub-winding as compared to a forward wound lap form sub-winding.

12. A method of manufacturing a device according to claim 10 whereby lap form sub-windings are wound on separate formers to produce individual "bobbins" which are then stacked into a slotted magnetically conducive base in a predetermined sequence and spacing to achieve a maximum of n-1 end turns overlapping and the bobbin connecting arms are then electrically joined in a plait like configuration to form the intertwined phases.

13. A method of manufacturing a device according to claim 10 whereby a completed phase winding is formed by direct winding of conductor strand into the slotted magnetically conducive base.

14. A method of manufacturing a device according to claim 10 whereby each phase is wound from a single continuous strand using a suitable winding machine and/or former to thereby create a string of interconnected lap form sub-windings.

15. A method according to claim 14 wherein each phase is made from a relatively thin and pliable electrical conductor strand which is wound into said string using an air coil winding machine.

16. A method according to claim 15 wherein alternating opposite offset end turns are accomplished by winding onto different appropriately configured formers.

17. A method according to claim 15 wherein alternating opposite offset end turns are accomplished by winding on the same formers but in opposite directions.

18. A method according to claim 15 wherein planar lap form sub-windings are first wound and then a press operation is used to subsequently achieve the alternating opposite end turn bends.

19. A method according to claim 15 wherein thermally bonded wire is used such that the final formed sub-windings can be heated to glue the loops of the sub-windings into a single solid component.

20. A method according to claim 14 wherein each phase is made from a relatively thick conductor strand and is wound using a CNC wire forming machine.

21. A method according to claim 15 or claim 20 wherein said completed phases are first plaited and then assembled into the magnetically conducive base.

22. A method of manufacturing a three phase device according to claim 14 wherein the assembly method includes the steps of:

placing active arms of an end sub-winding of a first phase string into two slots in an electrically conducive base with a first two vacant slots therebetween;

placing active arms of an end sub-winding of a second phase string into two slots in the base adjacent the first phase sub-winding with a second two vacant slots therebetween;

then placing the active arms of an end sub-winding of a third phase string into one of said first and second vacant slots between the assembled sub-windings of the first two phases; and

manually or automatically inserting the remaining sub-windings in staggered pairs to thereby achieve a plaiting configuration resulting in a maximum of two overlapping end turns.

23. A device according to claim 4 wherein each phase comprises a first set of interconnected lap form sub-windings all having end turns offset in a first direction and a second set of interconnected lap form sub-windings with all end turns offset in an opposite direction, with each sub-winding having an extended end connector

therebetween whereby plaiting is only required between those portions of the phases having the same direction of end turn offset and plaiting between overlapping end turns of the first and second sets is avoided.

24. A method of manufacturing a three phase device according to claim 23 comprising the steps of:

winding a first half of each phase from a single continuous strand using a former arrangement to create a first half string of interconnected lap form sub-windings having end turns all formed in a first direction;

winding a second half of each phase from a single continuous strand using a former arrangement to create a second half string of interconnected lap form sub-windings having end turns all formed in an opposite second direction;

assembling said first half of each phase in a plait like configuration onto said base without any end turns overlapping and with gaps between the active arms;

assembling said second half of each phase in a similar manner such that said second half of each phase is set into said gaps in said magnetically conducive base.

25. A method according to claim 24 wherein said first half of each phase is assembled directly into the magnetically conducive base and the second half of each phase is assembled onto a jig that mirrors the base and the assembled second half of each phase is then transferred onto the magnetically conducive base.

26. A device according to claim 3 wherein each lap form sub-winding has active arms that include only a single length of electrical conductor strand thereby resulting in a wave like winding formation comprising a series of spaced apart active arms that extend through spaced apart non-adjacent slots in the base, each active arm being

connected at alternate ends to an end turn or terminal thereby eliminating the need for separate connecting arms.

27. A device according to claim 26 wherein each of said end turns or terminals are offset from the plane in which the active arms are formed to provide clearance between overlapping end turns and so optimise packing density of electrical conductor within the slots of the magnetically conducive base.

28. A device according to claim 26 wherein each phase winding is manufactured as a simple pressing or forged component.

29. A device according to claim 3 having an axial flux configuration.

30. A device according to claim 3 having a radial flux configuration.

31. A device according to claim 3 having a linear configuration.